Chem 109 C

Fall 2014

Armen Zakarian
Office: Chemistry Bldn 2217

http://web.chem.ucsb.edu/~zakariangroup/courses.html
- **Office Hours**

  Mon, Wed - 9:00-9:50 am (or email)

- **Chemistry building, room 2217**

- **website:** [http://web.chem.ucsb.edu/~zakariangroup/courses.html](http://web.chem.ucsb.edu/~zakariangroup/courses.html)

- **email** - zakarian@chem.ucsb.edu

  make sure to include **Subject: 109C**
- 500 points total

- three midterm exams: 100 points each; lowest scoring is dropped

- a 300 point final exam

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**Disclaimer: no make ups for any tests**

- A 85-100%
- B 75-84.9%
- C 60-74.9%
- D 45-59.9%
holidays - no class

- Thanksgiving Wednesday, 11/26
- Veteran’s day off transferred to 12/1
- Stay tuned for schedule in the last two weeks of 12/1
  - 12/12
- All exams will be in this room, BRDA 1610
- All hats, cell phones, PDAs, calculators, ipods, and other electronic devices must remain stowed away during exams
- Bring a picture ID to the exam
- No makeups – a missed test can be the dropped test
Part 7

- Chapter 21 – Carbohydrates
- Chapter 22 – Amino Acids, Peptides, and Proteins
- Chapter 23 – Catalysis and Enzymes
- Chapter 24 – The Organic Mechanisms of the Coenzymes
- Chapter 25a – Organic Chemistry of Metabolic Pathways
- Chapter 25b – Lipids and Terpenes
- Chapter 26 – Nucleosides, Nucleotides, and Nucleic Acids

[Part 8 Chapter 29 - Synthetic Polymers etc.]
formula for success:

- read the textbook before coming to class
- come to class
- do the suggested problems
- do the suggested problems again
- study with a friend or in a group
- put emphasis on *understanding* vs. simple *memorization*
formula for success:

Attendance Matters

Fall 04 - Spring 08
I will use a combination of:

- blackboard
- PowerPoint, mostly for large biomolecules and Practice Problems

• read it
• do problems
• carbohydrates, sugars, saccharides
  >50% of all biomass
- **carbohydrates, sugars, saccharides**
  >50% of all biomass

- **lipids**
  fats/oils
  terpenes
  steroids, etc.

- D-glucose
- butter
- cholesterol
Biomolecules

- **carbohydrates, sugars, saccharides**
  >50% of all biomass

- **lipids**
  fats/oils
  terpenes
  steroids, etc.

- **amino acids, peptides, proteins**

D-glucose

butter

cholesterol

L-alanine
**Biomolecules**

- **carbohydrates, sugars, saccharides**
  >50% of all biomass

- **lipids**
  fats/oils
  terpenes
  steroids, etc.

- **amino acids, peptides, proteins**

- **nucleotides, nucleosides, RNA, DNA**
Synthetic (man-made) Compounds:

- **polymers (plastics):**
  
  ![Polystyrene molecule](image)
  
  etc

- **pharmaceuticals**

  ![Pharmaceuticals image](image)

  - penicillin
  - Zoloft
  - aspirin
  - morphine
Review of Stereochemistry

- **Organic chemistry** - chemistry of carbon, C
- **Valence number**: 4
• **chirality**

**Wikipedia:** An object or a system is **chiral** if it cannot be **superposed** on its **mirror image**. A chiral object and its mirror image are called **enantiomorphs** (Greek *opposite forms*) or, when referring to molecules, **enantiomers**. A non-chiral object is called **achiral** (sometimes also **amphichiral**) and can be superposed on its mirror image.
chirality

Wikipedia: An object or a system is chiral if it cannot be superposed on its mirror image. A chiral object and its mirror image are called enantiomorphs (Greek opposite forms) or, when referring to molecules, enantiomers. A non-chiral object is called achiral (sometimes also amphichiral) and can be superposed on its mirror image.
chirality

Wikipedia: An object or a system is chiral if it cannot be superposed on its mirror image. A chiral object and its mirror image are called enantiomorphs (Greek opposite forms) or, when referring to molecules, enantiomers. A non-chiral object is called achiral (sometimes also amphichiral) and can be superposed on its mirror image.
Review of Stereochemistry

D-glyceraldehyde

\[
\text{CHO} \\
\text{H} \sim \text{O} \\
\text{H} \sim \text{OH} \\
\text{HOH}_2\text{C} \sim \text{H} \\
\text{H}
\]
Review of Stereochemistry

D-glyceraldehyde

L-glyceraldehyde
Review of Stereochemistry

D-glyceraldehyde

\[ \text{CHO} \quad \text{HOH}_2\text{C} \quad \text{C} \quad \text{H} \]

L-glyceraldehyde

\[ \text{CHO} \quad \text{HO} \quad \text{C} \quad \text{CH}_2\text{OH} \]
CHAPTER 21
- All tests will be a \( \approx 50-50 \) mix of regular and multiple-choice questions.

\[ \approx 50 : 50 \]
extremely widespread in biosphere, >50% of all biomass

- main functions: 1) source of energy
  2) cell-cell communication, recognition

- origin of name: “carbo” (C) + “hydrates” (H₂O) = Cₙ(H₂O)ₙ = CₙH₂nOₙ

- main source: photosynthesis in plants

photosynthesis reaction:
Carbohydrates: Introduction

 sugars exist in cyclic form

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Carbohydrates: **Classification**

*based on number of single carbohydrate units*

**monosaccharides (simple carbohydrates)**
Carbohydrates: Classification

based on number of single carbohydrate units

monosaccharides (simple carbohydrates)

disaccharides
Carbohydrates: Classification

*based on number of single carbohydrate units*

- monosaccharides (simple carbohydrates)
  - disaccharides
    - oligosaccharides: 3 to 10 units
    - polysaccharides: >10 units
Carbohydrates: Classification

Based on carbonyl group

**Aldoses**
- Have aldehyde group
- Examples:
  - d-glucose
    - A polyhydroxy aldehyde
  - d-fructose
    - A polyhydroxy ketone

**Ketoses**
- Have ketone group
- Examples:
  - d-fructose
    - A polyhydroxy ketone
Carbohydrates: Classification

*Based on # of carbons in chain*

- **D-glucose**
- **D-arabinose**
- **D-erythrose**
Carbohydrates: Classification

The D and L notation

D-glucose

L-glucose
Carbohydrates: Classification

The D and L notation

D-glucose

L-glucose

D-glyceraldehyde

L-glyceraldehyde
PROBLEM 1 (modified)
Classify the following monosaccharides

arabinose

sedoheptulose

mannose
### Carbohydrates: Configurations of Aldoses

**Table 21.1 Configurations of the D-Aldoses**

<table>
<thead>
<tr>
<th>Aldose</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-glyceraldehyde</td>
<td><img src="image1.png" alt="Structure" /></td>
</tr>
<tr>
<td>D-erythrose</td>
<td><img src="image2.png" alt="Structure" /></td>
</tr>
<tr>
<td>D-threose</td>
<td><img src="image3.png" alt="Structure" /></td>
</tr>
<tr>
<td>D-ribose</td>
<td><img src="image4.png" alt="Structure" /></td>
</tr>
<tr>
<td>D-arabinose</td>
<td><img src="image5.png" alt="Structure" /></td>
</tr>
<tr>
<td>D-xylose</td>
<td><img src="image6.png" alt="Structure" /></td>
</tr>
<tr>
<td>D-lyxose</td>
<td><img src="image7.png" alt="Structure" /></td>
</tr>
<tr>
<td>D-allose</td>
<td><img src="image8.png" alt="Structure" /></td>
</tr>
<tr>
<td>D-altrose</td>
<td><img src="image9.png" alt="Structure" /></td>
</tr>
<tr>
<td>D-glucose</td>
<td><img src="image10.png" alt="Structure" /></td>
</tr>
<tr>
<td>D-mannose</td>
<td><img src="image11.png" alt="Structure" /></td>
</tr>
<tr>
<td>D-gulose</td>
<td><img src="image12.png" alt="Structure" /></td>
</tr>
<tr>
<td>D-idose</td>
<td><img src="image13.png" alt="Structure" /></td>
</tr>
<tr>
<td>D-galactose</td>
<td><img src="image14.png" alt="Structure" /></td>
</tr>
<tr>
<td>D-talose</td>
<td><img src="image15.png" alt="Structure" /></td>
</tr>
</tbody>
</table>

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Carbohydrates: Configurations of Aldoses

Number of stereoisomers = $2^n$

$n$ is number of stereocenters
Carbohydrates: Configurations of Aldoses

Number of stereoisomers = \(2^n\)

\(n\) is number of stereocenters

![D-glucose structure](image)
Carbohydrates: Configurations of Aldoses

Number of stereoisomers = \(2^n\)
\(n\) is number of stereocenters

D-glucose

total number of stereoisomers for aldohexoses:
Carbohydrates: Configurations of Aldoses

Number of stereoisomers = $2^n$

$n$ is number of stereocenters

![D-glucose structure](diagram)

**D-glucose**

**total number of stereoisomers for aldohexoses:**

**total number of stereoisomers for D-aldohexoses:**
<table>
<thead>
<tr>
<th>Carbohydrates: Configurations of Aldoses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rebuilding Table 21.1 (p. 982)</td>
</tr>
</tbody>
</table>
Carbohydrates: Configurations of Ketoses

Table 21.2 Configurations of the \( \alpha \)-Ketoses

\[
\begin{align*}
\text{dihydroxyacetone} & : \quad \text{CH}_2\text{OH} \\
& \quad \text{C} = \text{O} \\
& \quad \text{CH}_2\text{OH} \\
\text{d-erythulose} & : \quad \text{CH}_2\text{OH} \\
& \quad \text{C} = \text{O} \\
& \quad \text{H} \quad \text{OH} \\
& \quad \text{H} \quad \text{OH} \\
& \quad \text{CH}_2\text{OH} \\
\text{d-ribulose} & : \quad \text{CH}_2\text{OH} \\
& \quad \text{C} = \text{O} \\
& \quad \text{H} \quad \text{OH} \\
& \quad \text{H} \quad \text{OH} \\
& \quad \text{CH}_2\text{OH} \\
\text{d-psicose} & : \quad \text{CH}_2\text{OH} \\
& \quad \text{C} = \text{O} \\
& \quad \text{H} \quad \text{OH} \\
& \quad \text{H} \quad \text{OH} \\
& \quad \text{H} \quad \text{OH} \\
\text{d-fructose} & : \quad \text{CH}_2\text{OH} \\
& \quad \text{C} = \text{O} \\
& \quad \text{H} \quad \text{OH} \\
& \quad \text{H} \quad \text{OH} \\
& \quad \text{H} \quad \text{OH} \\
\text{d-sorbose} & : \quad \text{CH}_2\text{OH} \\
& \quad \text{C} = \text{O} \\
& \quad \text{H} \quad \text{OH} \\
& \quad \text{H} \quad \text{OH} \\
& \quad \text{H} \quad \text{OH} \\
\text{d-tagatose} & : \quad \text{CH}_2\text{OH} \\
& \quad \text{C} = \text{O} \\
& \quad \text{H} \quad \text{OH} \\
& \quad \text{H} \quad \text{OH} \\
& \quad \text{H} \quad \text{OH} \\
\end{align*}
\]

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**epimers:** diastereomers that differ in configuration at only one asymmetric center

- **d-ribose**
- **d-arabinose**
- **d-idose**
- **d-talose**
Carbohydrates: Epimers

PROBLEM 8 (modified)
How many stereoisomers are possible for

a. 2-ketohexose

b. an aldoheptose

c. a ketotriose